

LINES OF CLEAVAGE IN THE SKIN OF THE NEWBORN INFANT

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SIX FIGURES

Dupuytren (1834) discovered that piercing the skin with a round, pointed instrument like an awl produces not round holes but slitlike wounds indicating that "grain" or lines of cleavage exist. Such cleavage or tension lines in the skin are often called Langer's lines (Gray, 25th ed., Morris 11th ed.) because Langer (1861, 1862), by this method mapped the skin cleavage pattern for all parts of the body, determined the histological basis of skin cleavability, its variations with age and disease, and performed extensive experiments on the stretchability of skin and showed how this is related to its basic structure. A complete account of this whole problem and its many ramifications may be found in the work of Pincus ('27) and in more recent papers (see Cox, '41; Kraissl, '51).

MATERIAL AND METHODS

In this study about 50 newborn infants, ranging in length from 31 to 56 cm, were marked, 21 in toto and the remainder regionally. The technique is simple. The skin is pierced with any round, sharp, conically pointed instrument, such as an awl and the resulting wound appears as a short line. A second puncture is made in line with and 5 mm or so from the end of the closed wound, then a third puncture is made in line with the second and so on until a row of punctured

dashlike wounds is formed. These are made clearly visible by applying India ink to the punctured area and then wiping the skin clean. The ink darkly stains each wound but leaves the rest of the skin unaffected. The marking can be started anywhere, but the direction in which the lines will go is determined by the direction of the skin cleavage as evidenced by the wound closures. The accompanying photographs show how this technique works, for each inked dash is the result of one stained puncture wound.

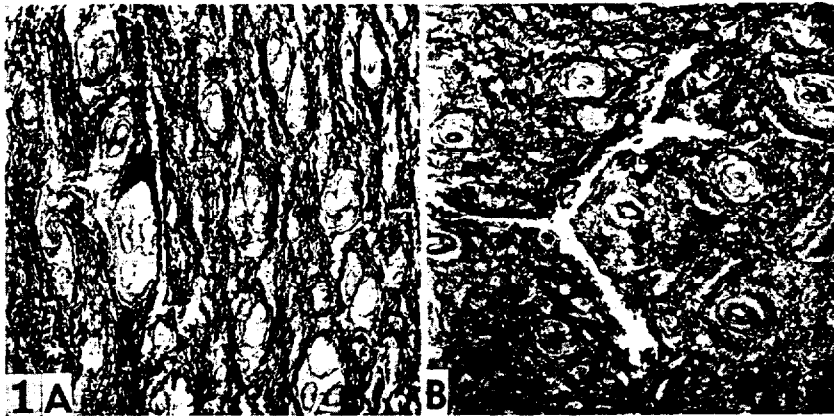


Fig. 1 Tangential sections through corium of skin from a newborn infant.

A Piece of skin from the neck showing parallel arrangement of collagenous fibers and one typical puncture wound.

B Piece removed 2 cm from A but lying over the sternum showing a jagged puncture wound and the irregular arrangement of collagenous fibers in this localized area.

OBSERVATIONS AND DISCUSSION

The anatomical basis for linear-shaped wounds is seen in the corium of the skin where the vast majority of the collagenous fibers in any spot are oriented in one direction. When these are pierced by a conically shaped instrument they merely separate as would the strands of a rope when pierced by a pencil, and, when the instrument is withdrawn, the fibers come together again leaving a slit to mark where they have been separated (fig. 1 A). Since the skin of the

whole body shows cleavage patterns, it would seem that the collagenous fibers of any area are oriented largely in the same direction. There are a few localized spots where jagged or triangular wounds result from punctures and here the

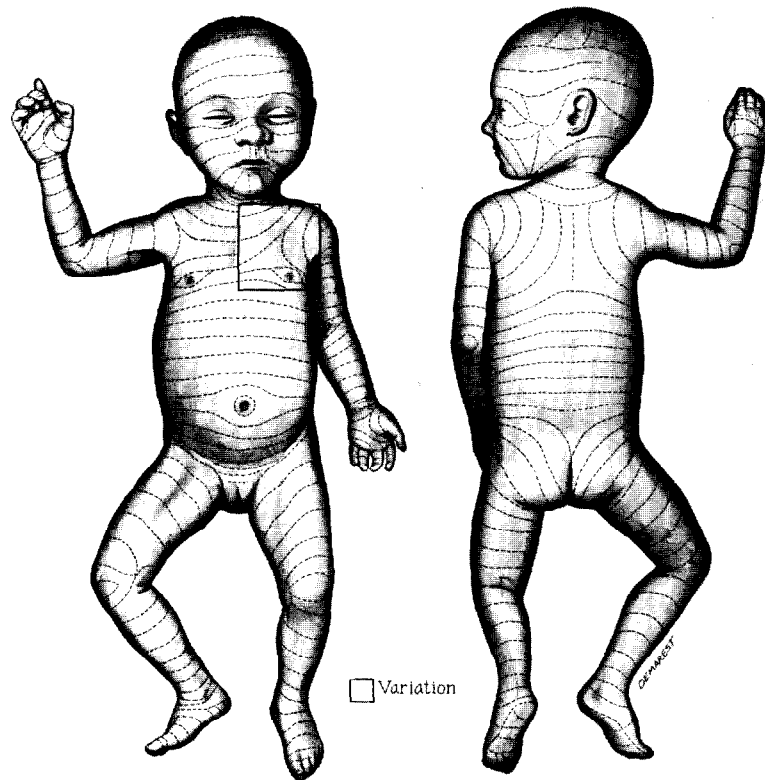


Fig. 2 Composite drawing indicating the skin cleavage pattern typical of a newborn infant.

collagenous fibers are diverse in their orientation. Such localized areas have been noted by others and, in infants, they seem to occur most commonly over the sternum, the interseapular area, and the anterior margin of the parotid region (fig. 1 B).

The extremities. The cleavage patterns in infants are remarkably constant and, in most regions, like those of the adult. A striking difference between adult and infant is found in the pattern of the extremities where infants show tension lines that are either annular or tight spiral in arrangement while in adults the lines are predominantly longitudinal. The annular pattern of the thigh or arm of the infant is carried on to the trunk in the regions of the pelvic and pectoral girdles and spreads out more posteriorly than



Fig. 3 Anterior and posterior views of the upper and lower extremities of a typical newborn infant.

anteriorly (fig. 2). Langer gives a figure of a 2½-years-old child where the annular markings on the arm are shown to extend back over the scapular region as concentric circles just as we find them, and Cox's figure for the adult shows this same arrangement but Langer's adult shows the lines over the scapular region to be nearly horizontal. The few adult bodies we have tested in this region correspond closely with the figures given by Cox. Both Langer and Cox show the cleavage lines in the free extremities of adults to be predominantly longitudinal while the skin wrinkle lines fig-

ured by Kraissl resemble instead the cleavage pattern of the infant. A similarity exists between infant and adult in the skin pattern over the knee or elbow which is a series of concentric lines on the extensor surface. Typical examples of cleavage line patterns found in extremities of infants may be seen in figures 2 and 3.

In the lower extremity the annular pattern of the thigh extends proximally to include the gluteal region also. When the extremity is completely abducted the most proximal puncture wounds of the thigh make a continuous ring that is just below the inguinal ligament anteriorly, follows the crest of the ilium posteriorly, then swings downward close to the anal opening and comes forward again at the lateral margin of the perineum (figs. 5 and 6).

Thorax. The markings of the thorax blend with those of adjoining regions. The annular lines of the upper extremity pattern continue back over the scapular region to the midline and to a less extent anteriorly while the necklace-like pattern of the cervical region extends down on the ventral aspect of the thorax over the manubrium. Between these two lie the nipples and around them the tension lines are arranged circumferentially for a variable distance. Below the nipples, the cleavage lines are regularly transverse. Hence, the upper chest region anteriorly will show considerable variation depending on the relative dominance of the different systems which meet here. Sometimes the neck pattern dominates and the gentle curves from the cervical region continue down over the thorax to blend imperceptibly with the transverse pattern typical of lower thorax and abdomen (fig. 2). In these cases the circular markings about the nipples are restricted and the annular lines from the upper extremity remain close to the axilla anteriorly. Or the upper extremity pattern seems to dominate (fig. 2 variation) with concentric lines radiating out on the chest from the axilla as a center. These blend in with the necklace-like lines coming down from the neck and the outermost lines, which reach the sternum, cross from one side to the other in a crisscross arrangement

rather than curving back to their own side. The concentric lines about the nipple do not extend out very far but, since this is an area of extensive potential growth, it is of paramount importance surgically to follow the cleavage lines carefully for a scar here in childhood may result in a deformed breast later in life.

Head and neck. The cleavage lines of the neck are like a necklace for they loop down symmetrically from each side anteriorly while posteriorly they cross the neck as straight lines.

On the face the pattern about the mouth is quite constant. On the skin of the lower jaw the lines radiate out like the spokes of a wheel from the lower lip as a center. On the upper lip, the lines between the mouth and the nose are straight and vertical. Lateral to the margin of the nose, the lines leaving the upper lip again radiate outward a short distance and then curve downward across the cheek. The lines that cross the lower border of the mandible continue only a short distance before reaching the upper limits of the transverse cervical pattern.

In the adult the tension lines of the skin about the eyes are annular in arrangement but in infants this is limited to the skin of the eyelids. From the margins of the orbit outward, the tension lines remain relatively transverse in direction, except that the lines above and below the orbit sometimes curve to meet one another lateral to the eyes. The lines across the forehead and extending for a variable distance up into the scalp are also transverse in direction. The transverse lines of the face below the eyes usually continue right across the nose up to the level of the inner angles of the eyes. Above this point, in the midline over the root of the nose and on to the level of the eyebrows or higher, most infants show a spot of vertically directed cleavage lines. The variations in this small area perhaps represent the development of the more widely annular pattern of lines about the eyes that is characteristic of adults.

The side of the face also exhibits variations because here the lines from three different areas merge. The transverse lines from below the eyes and over the nose extend back and meet the lines of the parotid region which in general extend from in front of the ear diagonally downward toward mouth and chin. From the corner of the mouth and upper lip, lines curve back across the cheek to meet these other systems and the resulting pattern seems determined by the relative dominance of the different areas involved. Hence, cases are found where the diagonal lines beginning in the parotid region extend with unbroken continuity down to the mouth and chin. Or the transverse lines characteristic of the upper face may extend clear back to the ear without a break. The usual pattern, however, is a fairly equal division of these three systems (fig. 4).

The scalp is the one region of the body where no constancy of pattern was visible. Over the forehead, across the temples and in the occipital region, the cleavage lines are consistently transverse in their arrangement. Over the calvaria, however, the patterns of no two individuals looked alike. In this connection measurements made on the skulls of some of these infants by M. Fasciana ('51) showed small irregularities on the surface of the head and the line of cleavage at any one point followed the steepest curvature through that point, which also represents the line of greatest tension.

Abdomen. The cleavage line pattern of the abdomen is predominantly transverse. The only break in this pattern is found about the umbilicus where the lines are concentrically arranged for a variable distance (1-4 cm) from the umbilicus as a center. Anteriorly, below the umbilicus the lines tend to maintain a transverse position laterally but in most specimens loop slightly toward the pubes in the midline (fig. 5). Hence, in the inguinal region the skin tension lines are more nearly horizontal than the incision often recommended in this region. If this fact is taken into consideration when making incisions, the cosmetic effect is often improved. Pos-

teriorly, the tension lines are regularly transverse from the scapular region above to the gluteal region below (fig. 2).

Perineum. This is a small region bounded laterally by the most proximal markings from the thigh, anteriorly by the



Fig. 4 Facial cleavage patterns of two individuals, front and profile views.

abdominal lines crossing the symphysis, and posteriorly by the lines of the gluteal region. The skin cleavage lines in the anal area of the perineum radiate out from the anal verge posteriorly like the spokes of a wheel and blend with the lines of the gluteal region while in the urogenital area the lines are generally straight and in the sagittal plane of the body (fig. 6). At the anterior limits of the perineum, these parallel lines from each side curve toward the midline to meet one another (fig. 5).



Fig. 5 Inguinal region: showing horizontal skin cleavage lines in lower abdomen and parallel lines of perineum joining anteriorly in midline.

Batson ('28) suggests that the cleavage patterns of skin may be the result of tensions from its own weight, from that of associated structures and from underlying growth. Weiss ('34) showed that growing connective-tissue cells orient themselves along lines of tension, so an understanding of the changing strains and stresses of development would probably make clear the origin of the infant's skin cleavage pattern. Burkard ('03) and Nussbaum ('23) have studied the origin and changes of skin cleavage patterns during foetal development and find evidence of skin cleavability before the corium

and collagenous fibers are histologically differentiated. Both authors find that during development the skin cleavage pattern shifts completely from predominantly transverse lines to predominantly longitudinal lines, and then back to a transverse system again. The authors are not in complete agreement as to the exact time and sequences of these changes nor are they clear as to why such radical shifts occur. A similar study has been reported by Gardner and Raybuck ('53). Our studies do not attempt to explain the genesis or



Fig. 6 Perineum: in posterior, anal triangle the cleavage lines radiate outward from anal verge while in anterior, urogenital triangle the lines run in the sagittal plane.

the shifting of the patterns of skin cleavage lines but the mapping of these lines in the newborn infant should be of interest to both anatomist and surgeon.

Although the final cosmetic appearance of a wound is not usually the primary concern of a surgeon, it should be taken into consideration, especially when dealing with infants and children since unsightly scars are distressing to both parent and child. Incisions placed at right angles to the lines of cleavage tend to "grow" in length out of proportion to the growth of the body. For example, a right rectus incision in

a 6-month infant extending from 1 cm below the costal margin to the left of the umbilicus will, 5 years later, extend from well above the costal margin to a point definitely below the umbilicus.

Surgeons who rarely treat infants admit that often the wounds close unsatisfactorily with poor skin healing, infection, and actual dehiscence. One of the authors (CEK) has observed several thousand wounds made parallel with and at right angles to the cleavage lines and there is no doubt that those made in conformity with the cleavage pattern heal faster, become infected less frequently and produce better cosmetic results.

SUMMARY

In a series of newborn infants, the pattern of skin cleavage or tension lines for the entire body was determined. The results show that in both extremities the lines are either annular or a tight spiral in arrangement which is in marked contrast to the pattern of the adult where the lines are predominantly longitudinal. In the thorax and abdomen the lines are regularly transverse except for localized annular rings about the umbilicus and nipples, and for extensions of the extremity patterns on the trunk in the regions of the pectoral and pelvic girdles. In the neck lines are necklace-like, looping in a caudad direction anteriorly and taking a transverse course posteriorly. Across the forehead, on the sides and back of the head, the lines are regularly transverse and this holds in general for the face too except as the pattern is modified by the openings for the mouth, nose and eyes. The skin of the scalp is readily cleavable but there is no constancy of pattern. Attention is called to the importance of these skin cleavage lines to surgeons working with children.

LITERATURE CITED

- BATSON, O. V. 1928 The anatomy of the corium. *Science*, 67: 198-199.
BURKARD, OTTO 1903 Ueber die Hautspaltbarkeit menschlicher Embryonen. *Archiv. f. Anat. u. Physiol. Anat. Abt.*, 13-22.
COX, H. T. 1941 The cleavage lines of the skin. *Brit. J. of Surg.*, 29: 234-240.

- DUPUYTREN, G. 1834 *Traité théorique et pratique des Blessures par Armes de Guerre*. J. B. Baillière, Paris.
- FASCIANA, M. J. 1951 Skin cleavages and their relationship to hair slope and tension on the scalp of newborn or stillborn babies. Thesis for M.S. degree, Jefferson Medical College, Philadelphia.
- GARDNER, J. H., AND H. E. RAYBUCK 1953 Development of cleavage line patterns to the human fetus. *Anat. Rec.*, 115: 309.
- GRAY, H. 1954 *Anatomy of the human body*. 26th ed. Ed. by C. M. Goss. Lea and Febiger, Philadelphia, pp. 1188-1189.
- KRAISSL, C. J. 1951 The selection of appropriate lines for elective surgical incisions. *Plas. and Recon. Surg.*, 8: 1-28.
- LANGER, K. 1861 *Zur Anatomie und Physiologie der Haut*. I. Über die Spaltbarkeit der Cutis. *Sitz. d. K. akad. d. Wiss. Wien.*, 44: 19-46.
- 1862 II. Die Spannung der Cutis. *Ibid.*, 45: 133-188.
- MORRIS, H. 1953 *Human anatomy*. 11th ed. Ed. by J. P. Schaeffer. Blakiston Co., New York, p. 70.
- NUSSBAUM, ILSE 1923 *Ueber die Spaltungsrichtung menschlicher Embryonen*. Inaug-Diss, Berlin.
- PINCUS, F. 1927 Die normale Anatomie der Haut. In: *Handbuch der Haut- und Geschlechtskrankheiten*. Ed. by J. Jadassohn, 1: 1-378. See pp. 60-76. Springer, Berlin.
- WEISS, P. 1934 In vitro experiments on the factors determining the course of the outgrowing nerve fiber. *J. Exp. Zool.*, 68: 393-448.